Guidelines for Benefit-Cost Analysis of PDM Applications

The purpose of this attachment is to provide information about how FEMA will evaluate the cost effectiveness of projects submitted for funding under the Pre-Disaster Mitigation (PDM) grant program. It also explains the requirements for performing Benefit-Cost Analysis (BCA) and providing proper documentation. Section B of this attachment includes sources for additional technical assistance.

This attachment frequently uses the terms BCA and BCR. BCA is a Benefit-Cost Analysis, which is the method by which the future benefits of a mitigation project are determined and compared to its cost. The BCR is the Benefit-Cost Ratio, which is a numerical expression of the cost effectiveness of a project. BCRs over 1.0 have more benefits than costs and are therefore cost effective.

As described in the Guidance for the PDM Program, FEMA will conduct a review of the cost effectiveness of projects submitted for grants. A BCA will be required for all mitigation projects. A National Benefit-Cost Review Panel that will be convened by FEMA will evaluate these BCAs. The panel will evaluate the reasonableness, credibility, and accuracy of all BCAs by reviewing the data provided in the application and the methods used in the analysis, focusing on:

- Technical accuracy
- Supporting documentation
- Source credibility

BCAs that are technically correct and thoroughly documented will be validated and the BCR incorporated directly into the overall National Ranking (see Attachment 1, Grant Guidance FY 2003 Pre-Disaster Mitigation Program – Competitive Grants, DFDA 83.557). Projects where BCAs are inadequately documented or where critical data or sources appear unreasonable will be less competitive, and in some cases may be deemed completely inadequate and removed from funding consideration.

This attachment is divided into the following parts.

A. BCA Requirements

B. Facilitating BCA for Sub-Applicants

C. Identifying Cost Effective Projects

D. Technical Guidance on BCA and Documentation

E. Documentation Guidelines

F. Alternative BCA Methodology for Repetitive Loss Properties

G. Extreme BCRs

Appendix I: Data Documentation Technical Guidance and Data Lists

Appendix II: Data Documentation Template

A. Benefit-Cost Analysis Requirements

The FY 2003 PDM program was established by Congress as a nationally competitive program. The BCR of each mitigation project will be a major factor in the evaluation of PDM projects. Mitigation projects with higher BCRs are more likely to be funded in the nationally competitive PDM program. Mitigation projects with BCRs less than 1.0 will not be eligible for PDM funding.

A BCA is required for all PDM mitigation projects grant applications, including repetitive flood loss properties and substantially damaged flood loss properties. However, BCAs are not required for PDM mitigation planning grant applications.

For the PDM program, the sub-applicant or applicant is required to do the BCA for their mitigation projects as part of the project application. In the past, FEMA sometimes has performed BCAs for its other grant programs as a form of technical assistance to applicants. Because PDM is a competitive program and FEMA does not want to favor any particular proposal or applicant, the Agency will not perform BCAs on behalf of applicants or sub-applicants but will provide a range of technical assistance (discussed later in the attachment).

FEMA's BCAs are governed by guidance from the Office of Management and Budget (OMB). OMB Circular A-94 describes the economic principles and methods by which most federal programs must determine the cost effectiveness (i.e., BCR) of funded projects. OMB A-94 states: *"Analyses should include comprehensive estimates of the expected benefits and costs to society based on established definitions and practices for program and policy evaluation. Social net benefits, and not the benefits and costs to the Federal Government, should be the basis for evaluating government programs or policies that have effects on private citizens or other levels of government."*

Following OMB A-94, the benefits of mitigation projects are counted broadly not narrowly. In simple terms, it is proper to count all of the direct benefits of mitigation projects. The direct benefits are simply the avoided damages, losses, and casualties that may occur in natural disasters. As a general rule of thumb, if a natural disaster results in direct damages, losses, or casualties and a mitigation project avoids or reduces them, then it is acceptable to count these benefits for a FEMA BCA.

The benefits of mitigation projects are simply avoided damages, losses, and casualties. Examples of common benefits include avoided (or reduced):

- Damages to buildings, contents, or infrastructure
- Economic impacts of loss of function of buildings
  - Displacement costs for temporary quarters
  - Loss of public services
  - Loss of net business income
- Economic impacts of loss of function of infrastructure
  - Road or bridge closures
  - Loss of utility services
- Deaths and injuries

OMB guidance excludes some benefits from consideration when conducting a BCA. The most important of these are indirect or "multiplier" effects. For example, long-term changes

in regional economic activity, future employment, or tourism cannot be considered benefits of mitigation projects because they are not directly linked to the project.

For further details of categories of benefits that may or may not be counted see "What is a Benefit?" This document provides standardized benefit categories to count, standardized approaches and standardized data inputs for many common mitigation projects. This document is located on the Mitigation BCA Toolkit CD.

B. Facilitating Benefit-Cost Analysis for Sub-Applicants

Many sub-applicants will be faced with doing BCAs for the first time. Although BCA is a technical process, FEMA has developed software, written materials, and training that simplify the process.

FEMA has a suite of BCA software for a range of major natural hazards: earthquake, fire (wildland/urban interface fires), flood (riverine, coastal A-Zone, Coastal V-Zone), hurricane wind (and typhoon), and tornado.

Sometimes there is not enough technical data available to use the software mentioned above. When this happens, or for other common, smaller-scale hazards or more localized hazards, BCAs can be done with the Frequency Damage Method (i.e., the Riverine Limited Data module), which is applicable to any natural hazard as long as a relationship can be established between how often natural hazard events occur and how much damage and losses occur as a result of the event. This approach can be used for coastal storms, windstorms, freezing, mud/landslides, severe ice storms, snow, tsunami, and volcano hazards.

Applicants and sub-applicants are encouraged to use FEMA software. This will ensure that the calculations and methods are standardized, speeding the evaluation process. Alternative BCA software may also be used but only if the FEMA Regional Office and FEMA Headquarters approve the software in advance. Approvals must be written, dated, and signed. BCAs conducted with non-FEMA software not approved in advance by FEMA will be removed from funding consideration for the FY 2003 PDM program.

FEMA has prepared a Mitigation BCA Toolkit CD. This CD includes all of the FEMA BCA software, technical manuals, BC training courses, and other supporting documentation and guidance. The Mitigation BCA Toolkit CD is available free from FEMA regional offices or via the BC Hotline (bchotline@urscorp.com or (301) 670-3399 x710). The BC Hotline will have a toll free number starting July 31, 2003, at (866) 222-3580. The BC Hotline is also available to provide BCA software, technical manuals, and other BCA references as well as to provide technical support for BCA.

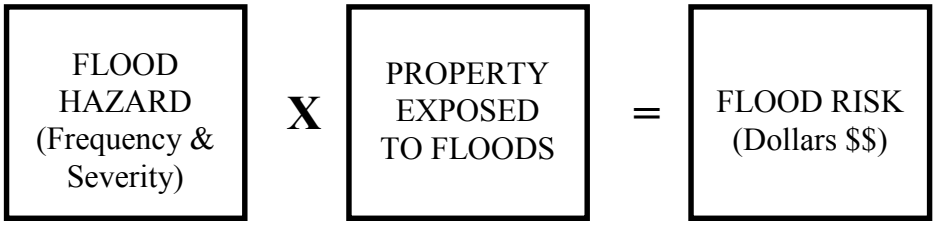
For further technical assistance, applicants or sub-applicants may contact their State Mitigation Office, the FEMA Regional Office, or the BC Hotline. FEMA and the BC Hotline provide technical assistance regarding how to perform a BCA but will not perform the actual BCA. If the sub-applicant is re-submitting a project for which FEMA or a state performed the BCA in the past, the applicant and sub-applicant certify that they accept the BCA as their own by submitting it as part of their application. Applicants and sub-applicants are encouraged to revisit those analyses to ensure they demonstrate maximum project benefits.

C. Identifying Cost Effective Mitigation Projects

Applicants and sub-applicants are encouraged to consider the idea of "risk" when identifying and analyzing mitigation projects for the PDM program. Risk is simply the threat to the built environment (buildings and infrastructure) and people (casualties) expressed in terms of dollars.

Risk depends both on the frequency and severity of natural hazards and on the vulnerability of the built environment and people. The highest risk situations have a combination of high hazard, high vulnerability, and high value of inventory (buildings, infrastructure, people) exposed to the hazard. This concept of risk is summarized in the figure below (using flood as an example):

HAZARD & RISK



While it is generally true that high-risk situations have the highest potential benefits, the cost effectiveness of mitigation projects also depends directly on how much they cost. The BCR (which will be used to rank projects) is a *comparison* of benefits to costs. Even in situations where risk appears relatively small, such as a rural culvert washing out every year, an inexpensive mitigation project may be highly cost effective. Projects that mitigate "big" risk are not necessarily more cost effective.

D. Technical Guidance on Benefit-Cost Analyses and Documentation

It is the applicant and sub-applicant's responsibility to provide a BCA that is reasonable, credible, and well documented. A National Benefit-Cost Review Panel (see Section F) will be convened to rank all PDM projects by BCR. The Review Panel evaluation and ranking will be based solely on documentation provided in the project application. Thus, it is essential that every application provide full documentation of the BCA.

A well-documented BCA means that knowledgeable subject matter experts (BC analysts) should be able to recreate the sub-applicant's BCA from the supporting documentation, from the project application, without any additional explanation.

Each application must include the following essential documentation.

1. **A narrative describing the details of the mitigation project, including what the hazard is (i.e., flood), what damages and losses it is causing, and how the mitigation project addresses the problem.**
2. **Documentation of the mitigation project scope and cost, including engineering cost estimates whenever possible.**
3. **An electronic or paper copy of the full benefit-cost analysis (an electronic copy is strongly encouraged).**
4. **Full documentation of each data entry that affects the numerical BCR (see further details below). In the FEMA software, green and blue data entry cells represent entries that affect the numerical BCR. Thus, when using the FEMA software, documentation should be provided for the source and validity of each green and blue data entry cell input into the BCA software.**

When evaluating projects, FEMA will consider the accuracy of data, completeness of documentation, and the credibility of data sources (see Appendix I). In a nutshell, the numerical values, sources, and assumptions in a BCA must make sense and be well documented.

The following technical guidance is intended to help applicants and sub-applicants provide BCAs that meet the criteria of reasonable, credible, and well documented.

1. Use the FEMA BCA software whenever possible.
2. An application's project scope should be carefully explained with enough detail to understand exactly which area/buildings/people are affected by the project and what the project will do to mitigate risk. For example, "acquire and demolish 18 houses on Main Street" is a clear statement of a mitigation project when accompanied by more details (addresses, building types, square footages, building values, first floor elevations, etc.). On the other hand, "implement measures to reduce flooding on Main Street" is not detailed enough.
3. Project costs should be fully documented and supported with cost estimates from appropriate sources. For BCA, the project cost is always the total project cost not simply the FEMA share.
4. BCA is a net present value calculation that takes into account the useful life of mitigation projects and the time value of money. For all FEMA projects, the OMB-mandated discount rate of 7% must be used for performing BCAs. In addition, a useful life appropriate for the specific mitigation project must be used for all BCAs. For guidance on project useful lifetimes, see "What is a Benefit?" and other guidance on the Mitigation BCA Toolkit CD or contact your FEMA Regional Office or the BC Hotline.
5. Each data input for BCA that affects the numerical BCR must be fully and carefully documented. It is recommended to use standard FEMA methodology and default data when it applies.
    a. Some data inputs may be based on national or typical data, and use of such data is encouraged when applicable to specific projects. Examples of such data include the damage data percentages in FEMA BCA software and typical values for economic impacts of road and bridge closures and loss of function of utilities (reference: *What is a Benefit?*).

b. Many data inputs are project specific and must be documented by local data. Examples of such data include building types, building areas, building values, first floor elevations, values of public service, and occupancy.

E. Data Documentation Guidelines

It is important to document all of the data in a BCA that affects the numerical BCR. Documentation must be complete enough so the Review Panel may evaluate the project and the accuracy of the data, using only the information in the project application file. For example, a statement that "damages in the flood of April 1, 2003 totaled about $2,000,000 in Smalltown" is not sufficient. Rather, documentation should describe where the damage occurred, with breakdowns of damages to buildings, contents, infrastructure, people, etc., and enough detail to evaluate the accuracy of the damage estimate.

Documentation must include hazard data (flood, earthquake, etc.), building or infrastructure damage data, and information supporting economic losses and casualties.

Data from FEMA BC software and values from FEMA guidance such as "What is a Benefit?" will be accepted as credible. Data from recognized sources such as the US Geological Survey (USGS), National Oceanic and Atmospheric Administration (NOAA), state agencies, and academic organizations have a high degree of credibility. Where data is purely local, supporting documentation from an engineer or other qualified source improves the credibility and robustness of documentation. Any deviations from standard procedures, methods, techniques, or guidance must be thoroughly explained and documented. In all cases, applications should include written backup for the data that is used (copies of web pages, copies of data from Flood Insurance Studies, etc. Appendix I contains lists of important BCA data inputs for mitigation projects addressing the major hazards.

Appendix II contains a sample data documentation template for flood hazard mitigation projects. The template defines the data, lists sources, and describes what documentation is appropriate. The Mitigation BCA Toolkit CD has further examples and blank hazard-specific templates for use by Applicants or Sub-Applicants. The templates should be used to ensure that data, documentation and source credibility are adequate for FEMA's review.

F. Alternative BCA Method for Repetitive Flood Loss Properties

FEMA is introducing a pilot program that allows a simplified, BCA methodology for certain repetitively flooded properties insured under the National Flood Insurance Program (NFIP). These are properties that have experienced four or more insured flood losses or have the highest severity of flooding (i.e., cumulative losses paid exceeds the property value). There are approximately 10,000 such properties, which represent about one-quarter of one percent of all NFIP policies. This alternative methodology may only be applied to projects meeting the following criteria.

- Projects that address pilot NFIP repetitive loss properties on the list provided with this memorandum
- Projects that are designed to accomplish property acquisition/demolition, structure relocation, or structure elevation
- For structural elevation projects, each structure must provide a minimum one-foot of freeboard above the base flood elevation (BFE) or higher elevation as needed to

provide 100-year flood protection plus one foot of freeboard. More stringent state or local requirements must be met where applicable.

For these pilot NFIP repetitive loss structures, FEMA has calculated "Potential Future Damages Avoided." For acquisition, relocation, or elevation projects for properties on this list, a BCR may be calculated simply as:

Potential Future Avoided Damages / Total Project Cost = BCR.

This analysis considers only insured losses (building and contents damages). Other economic impacts (displacement costs for temporary housing and uninsured losses) are not included. If desired, a traditional BCA can be conducted to consider only benefits other than avoided building and contents damages. Then the total benefits are the sum of the Potential Future Avoided Damages, and the additional benefits and the BCR may be calculated simply as:

(Potential Future Avoided Damages + Additional Benefits) / Total Project Cost = BCR.

G. Extreme BCRs

There are no realistic hazard mitigation projects with extreme BCRs of 100's or 1000's. To have such extreme BCRs, the (average annual) damages would be many times the replacement value of the building. Such situations would be impossible to tolerate economically, and/or the facility would have to be damaged so many times per year that repairs would be literally continuous and endless.

Based on experience, we have found that many reported BCRs of 10 to 100 are also incorrect, based on illogical or faulty data or analyses. There are a few mitigation projects where BCRs may approach or exceed 10, but these are rare and are most often where a non-structural mitigation project protects something of much higher value. Examples may include storm shutters for critical facilities in hurricane prone areas or non-structural earthquake projects that protect very high value or critical facilities. Therefore, PDM projects submitted with extremely high BCRs will be reviewed very carefully.

Appendix One
Data Documentation Technical Guidance and Data Lists

This appendix contains additional technical information about BCA and hazard specific lists of data parameters for BCA.

As discussed in the BCA sections of the PDM Guidance, all BCAs submitted by applicants or sub-applicants will be evaluated by a National Review Panel for three general qualities.

- Technical Accuracy
- Supporting Documentation
- Source Credibility

All input data that affects the numerical BCR must be thoroughly documented by the applicant or sub-applicant in the project application. Evaluation and ranking will be based solely on information provided in the application.

There are several evaluation criteria that apply to every mitigation project, for every type of hazard.

1. Use of FEMA BCA software is strongly encouraged. Non-FEMA software may be used only if both the FEMA Regional Office and FEMA Headquarters approve the software in advance and in writing.
2. The OMB-mandated discount rate of 7% must be used for all BCAs.
3. Mitigation project scope must be explained in sufficient detail so that evaluators may understand fully what the hazard is (i.e., flood), what damages and losses it is causing, how the project works to mitigate the identified problems, and how effective the project will be in reducing future damages and losses. Acquisition/relocation is the only common mitigation project that is 100% effective in avoiding future damages and losses. For all other types of projects, documentation must be provided to determine how effective the project will be in reducing damages after mitigation at various levels of hazard severity or frequency.
4. Project costs must be fully documented and supported with engineering cost estimates whenever possible. For BCA, the project cost is always the total project cost, not the FEMA share. If annual maintenance costs are necessary for a mitigation project to be effective, such costs must be included and documented. Similarly, if temporary relocation of occupants is necessary in order to complete a mitigation project (i.e., seismic structural retrofit of building), then such costs must be included and documented.
5. Project useful life must be consistent with FEMA guidance and practice. See "*What is a Benefit?*" guidance and the technical manuals for the FEMA BCA software or consult FEMA Regional Offices or the BC Hotline for guidance on useful life for specific mitigation projects.
6. The benefits of avoiding or reducing casualties may be significant for some types of projects (i.e., many seismic projects). However, for many common types of mitigation projects, such as flood projects other than flash flooding or dam failure, life safety benefits are often negligible or non-existent. Any BCA that claims life safety benefits must carefully and thoroughly document the direct connection between the proposed mitigation project and reductions in expected future deaths and injuries. For FEMA statistical values for injuries and deaths, see "*What is a Benefit?*" guidance.

7. Many of the FEMA BCA modules contain typical or default data. Use of such data will be accepted as long as the data is applicable to the specific mitigation project; however, applicants and sub-applicants must understand the applicability of the typical or default data. For example, use of residential depth-damage percentages for infrastructure or a wastewater treatment plant or use of seismic damage percentages for buildings for non-structural or infrastructure projects would be incorrect and would impact the review and evaluation process.

The number and types of data inputs for BCA vary depending on the hazard being addressed, the type of mitigation project, and other factors. The Common Data Inputs for BCA section of this attachment summarize the major data inputs required for common mitigation projects for the most common hazards.

The relative importance of each data input on the BCR varies significantly from project to project. For example, life safety benefits (avoided deaths and injuries) may be very important for some types of mitigation projects (i.e., seismic structural retrofits of buildings) but may be negligible or non-existent for other types of projects. Data inputs are listed in approximate order of importance, but applicants and sub-applicants must realize that the actual order of importance varies from project to project.

For hazards that are addressed by less-common mitigation projects (Example: utility protective measures for ice storms), the specific data inputs required for BCA may vary from those in the Common Data Inputs for BCA section of this attachment. In such cases, applicants and sub-applicants are responsible for ensuring that all data inputs for their specific mitigation projects are thoroughly documented, regardless of whether or not the data inputs are included on the following data lists.

Many of the data items listed below have specific “terms of art” meaning in BCA. Applicants, sub-applicants, and BC analysts are encouraged to obtain technical materials, take training when available, and contact the BC Hotline at bchotline@urscorp.com or by phone at (301) 670-3399 x710 (toll free starting July 31, 2003 at (866) 222-3580), or FEMA Regional Office if they need assistance with understanding these data terms or with any other aspects of BCA.

Common Data Inputs for BCA

Frequency-Damage Analysis Methodology (Flood and Most Other Hazards)

The frequency-damage module (Riverine Limited Data Module) was designed for BCA of flood mitigation projects for locations without quantitative flood hazard data (i.e., outside of mapped flood plains) and/or without first floor elevation data. This module can also be used for any other hazard (i.e., ice storms, snow, windstorms) for which frequency-damage relationships can be derived from historical damage data and/or engineering judgment.

The frequency-damage method should never be used for BCA of seismic, hurricane wind, or tornado mitigation projects. For these hazards, national quantitative hazard data exists, and thus, much more accurate BCAs can be conducted using the hazard specific BCA software for earthquakes, hurricane wind, or tornadoes. Common data inputs include:

1. Documentation of event frequency.
2. Pre-mitigation damages and losses in high frequency events (1- to 10-year recurrence interval).
3. Pre-mitigation damages and losses in moderate frequency events (10- to 50-year recurrence interval).
4. Effectiveness of mitigation project – to what level of event does the project avoid or reduce future damages?
5. All pre-mitigation damages or losses with high value.
6. All estimates of deaths and injuries.
7. Pre-mitigation damages in losses in low frequency events (>50-year recurrence interval).

Engineering Data Analysis Methodology
Flood Hazards (Riverine, Coastal A-Zone and Coastal V-Zone Full Data Modules)

The engineering data analysis method uses quantitative data to determine the frequency and severity of flood events and engineering data to calculate damages and losses before and after mitigation. Common data inputs include:

1. Finished floor elevation.
2. Flood elevation data (typically 10-, 50-, 100- and 500-year).
3. Flood discharge data (Riverine only).
4. Building type.
5. Building replacement value.
6. Depth-damage functions (if not FEMA software typical values).
7. Building damage percentage resulting in demolition.
8. Contents replacement value.
9. Functional downtime and value of loss of service (especially if large fraction of benefits).
10. Continuity premium for loss of public services (if used).
11. Displacement times and costs (if not FEMA typical values).
12. Building area.

13. Net business income (if commercial property).

Engineering Data Analysis Methodology
Seismic Hazards (Seismic Full Data Module: Structural Mitigation Projects for Buildings)

Note: Several important aspects of the Seismic Full Data BCA Module are outdated. See the Mitigation BCA Toolkit for essential updates for seismic hazard data, seismic damage functions, casualty rates, and other critical inputs for BCA. **Do not use the Seismic Full Data Module without incorporating these updates.** Common data inputs include:

1. Seismic hazard data (see Mitigation BCA Toolkit).
2. Soil type (see Mitigation BCA Toolkit).
3. Building structural system type.
4. Building replacement value.
5. Seismic-damage functions (if not FEMA software typical values – see Mitigation BCA Toolkit).
6. Building damage percentage resulting in demolition.
7. Building occupancy.
8. Casualty rate estimates (see Mitigation BCA toolkit).
9. Contents replacement value.
10. Functional downtime and value of loss of service (especially if large fraction of benefits).
11. Continuity premium for loss of public services (if used).
12. Displacement times (if not FEMA typical values) and costs.
13. Building area.
14. Net business income (if commercial property).

<u>Notes on other Types of Seismic Hazard Mitigation Projects</u>

The Seismic Full Data Module should not be used for non-structural mitigation projects such as bracing or anchoring contents, equipment, or for projects addressing non-structural building elements such as ceilings or windows. For such projects, the Non-Structural Seismic Module should be used (see Mitigation BCA Toolkit). The Non-Structural Module contains BCA templates and typical data for many types of common non-structural projects. The specific data required varies from project to project. Data documentation requirements are generally similar to those for buildings. For non-structural projects, documentation should be provided for all data entries applicable to the specific type of mitigation project.

Engineering Data Analysis Methodology
Hurricane Wind Hazards (Hurricane Wind Full Data Module)

1. Wind hazard data
2. Distance inland
3. Building type
4. Building replacement value

5. Wind-damage functions (if not FEMA software typical values)
6. Effectiveness of mitigation project in reducing damages
7. Building damage percentage resulting in demolition
8. Contents replacement value
9. Functional downtime and value of loss of service (especially if large fraction of benefits)
10. Continuity premium for loss of public services (if used)
11. Displacement times (if not FEMA typical values) and costs
12. Building area
13. Net business income (if commercial property)

Wildland/Urban Interface Fire Mitigation Projects
(Wildland Fire BCA Module)

1. Fire hazard data – standard method
   a. Sample area of similar fire hazard
   b. Total acres burned in sample area over time period
   c. Number of years in time period
2. Fire hazard data – user-defined burn interval – full documentation is extremely important for use of user-defined burn interval
3. Damages and losses before mitigation: All of this data must be ONLY for the specific geographic area directly affected by the mitigation project
   a. Building value
   b. Contents value
   c. Infrastructure
   d. Timber value
   e. Fire suppression costs
   f. Other
   g. Number of residents
   h. Annual death rate per 1,000,000
4. Effectiveness of mitigation measure (percent reduction in damages and losses) – Full documentation is extremely important for this data entry. Consultation with fire service professional is highly recommended.

Standard Analysis Methodology
Tornado Hazards

1. Building type
2. Shelter design wind speed
3. Occupancy [numbers vs. time]
4. Injury and mortality percentages [curves], if default not used
5. Building dimensions
6. Building damage percentage resulting in demolition
7. Shelter floor area

Appendix Two
Data Documentation Template

Flood Mitigation (Riverine, Coastal A-Zone, Coastal V-Zone)
Engineering Data Analysis Methodology [Full Data BCA Modules]

Data Type	Value	Description	Documentation	Source
Finished floor elevation [FFE]	Expressed in feet above mean sea level [MSL]	• The FFE is the elevation of the top of the finished flooring of the lowest floor. • The elevation should be measured at the first floor *above grade*, not at the basement level. The FFE is a primary determinant of flood risk.	• Survey, Elevation Certificate, other formal records. • If estimated, include a description of how derived and copies of all pertinent references, such as topographic maps, surveys, photographs of mud lines, etc. • If estimated, indicate who performed the estimate.	Engineers, Licensed/Registered Surveyors, Certified Floodplain Managers, local floodplain administrators, insurance agents, planners with floodplain experience.
Flood Elevation Data	Elevations of 10-, 50-, 100- and 500-year floods	Specific values read from flood profile graph (in the Flood Insurance Study) for the project location along the reach of the flood source (river).	Provide copy of flood profile graph and location of project site along the bottom axis of the profile.	FEMA Flood Insurance Study or local flood study.
Flood Discharge Data	Stream discharges (volumes) for 10-, 50-, 100-, and 500-year floods	The volume of water that will flow down a river or stream during a specified flood. Discharge is usually measured in cubic feet per second.	Provide copy of discharge table	FEMA Flood Insurance Study or local flood study.

Data Type	Value	Description	Documentation	Source
Building type	Selection of one of the building types	• How many stories and whether or not there is a basement. • Building type is a major determinant of anticipated damage from floods.	Tax records, appraisals, letters from homeowners, photographs, etc.	Homeowner, local building inspection department, local tax assessor's office, title documents, etc.
Building replacement value	Expressed as dollars per square foot	• The cost for labor and materials to build a similar structure in the same place. • A key determinant of the amount of damage from future floods.	Letter from construction or contracting firm, letter from local building inspection department, photocopy of page or pages from standard cost reference manuals.	• Local building inspector, contractor, builder, construction company, architect, or building engineer. • Standard references such as Marshall & Swift Residential Cost Handbook, Means Square Foot Cost Guide, etc.
Depth-damage function	Expressed as the percent damage of the building replacement value at each flood depth.	• Estimate of building damages at each flood depth. • Relationship between flooding depth in feet and damages in dollars; as the flood depth increases, damages will typically increase.	• If typical values in FEMA software are used, then provide printout of software. • If user-determined values are used, provide full documentation of reasons for differences from FEMA typical values.	• FEMA typical values in software or • Estimates based on historical losses and engineering judgment.

Data Type	Value	Description	Documentation	Source
Building damage (percentage) that would result in demolition	Percentage of building replacement value	• FEMA standard value is 50%. • Low cost or poorly maintained structures may have lower values; structures of historical or other importance may have higher values. • Lower demolition percentages result in higher BCRs.	• No documentation required if standard value used. • Provide documentation and the basis of the estimate for values other than 50%.	Values other than 50% should include consultation with real estate appraiser, economist, local building inspector, contractor, builder, construction company, architect, building engineer, planners, etc.
Contents value	Expressed as dollars	• The cost to replace the contents of a structure. • Contents damage includes items like furniture, office equipment, etc. • Contents do not include items that are permanent parts of the building, such as electrical and plumbing systems. • FEMA standard for residential structures is 30% of the replacement value of the structure.	• 30% value for residential structures: no documentation required. • For other values for residential buildings and for non-residential structures, provide detailed descriptions of contents, value, and the means by which value was assessed.	• No source required if a residential structure and FEMA standard is used. • Otherwise, review insurance records, appraisals, purchase receipts, and estimates based on current market prices for similar contents.
Functional Downtime	Days, increases with flood depth (building percent damage)	The time period for which public or commercial services are lost from a building.	• For ordinary buildings, typical values in FEMA software. • For critical buildings, use "*What is a Benefit?*" guidance.	• No local source required if FEMA typical values are used. • Developing non-standard values may involve working with organization or agency providing service.

Data Type	Value	Description	Documentation	Source
Value of loss of service	Dollar value of loss of public services	For public services, daily value of service is estimated by the daily cost of providing service.	• Documentation of annual operating budget for public facility. • For critical facilities, see "*What is a Benefit?"* guidance.	• Agency providing service.
Continuity premium	Multiplier on ordinary value of service	Applies only to services critical to immediate disaster response and recovery (Police, Fire, etc.)	• No documentation required if FEMA standard values are used. • Exception to standard values requires detailed explanation of source used and method applied.	• See "*What is a Benefit?*" guidance for standard values. • Developing non-standard values may involve working with organization or agency providing service.
Displacement costs	Expressed as dollars per square foot per month, and one time and monthly costs.	• The costs borne by occupants during the time when a structure is flooded and they are unable to occupy it. • Costs may include rent for alternative living spaces, rent for storage space, additional commuting time, additional day care, unpaid time off work, rental trucks, etc. • All these may be estimated when supported by credible documentation and sources.	• Alternative living space documented by copies of rental costs from realtors, leasing agents, or newspapers, among others. • Rental for storage spaces may be supported by copies of advertising, or records of contacts with rental companies. • Extra commuting costs and day care may be estimated as long as the estimation methodology is explained.	• Photocopies of ads for rental spaces in the community, records of phone contacts with rental agencies, or receipts from similar rentals. • For residential properties, typical displacement costs are $0.50 to $1.00 per square foot per month. Typical other monthly costs and one-time costs are $500 each. • Use standard figures where possible [i.e. 34.5 cents per mile for additional commute].

Data Type	Value	Description	Documentation	Source
Displacement time	Days, increases with flood depth (building percent damage)	The time period for which occupants are expected to be displaced to temporary quarters due to flood damage	• No documentation required if FEMA standard values are used for residential and other ordinary buildings use typical values. • Provide data derivation method for techniques used.	See "*What is a Benefit?*" guidance for residential and critical facilities.
Building floor area	Expressed in square feet	The total enclosed area in the structure. Used in conjunction with replacement value to determine anticipated flood damages in various potential events.	Various forms are acceptable, including tax records, appraisals, surveys, estimates from photographs, etc.	• Local tax office or appraisers office, surveyor, title documents with building footprint, etc. • Homeowner estimates or measured drawings accompanied by photograph, etc.
Loss of business income	Net (not gross) business income	For commercial facilities, loss of net business income is the measure of loss of function when damage results in closure of the facility.	No documentation required if FEMA standard values are used.	The FEMA HAZUS earthquake loss estimation software has typical values for many classes of business - applicable to all hazards.